Deep Dive into Deep Learning

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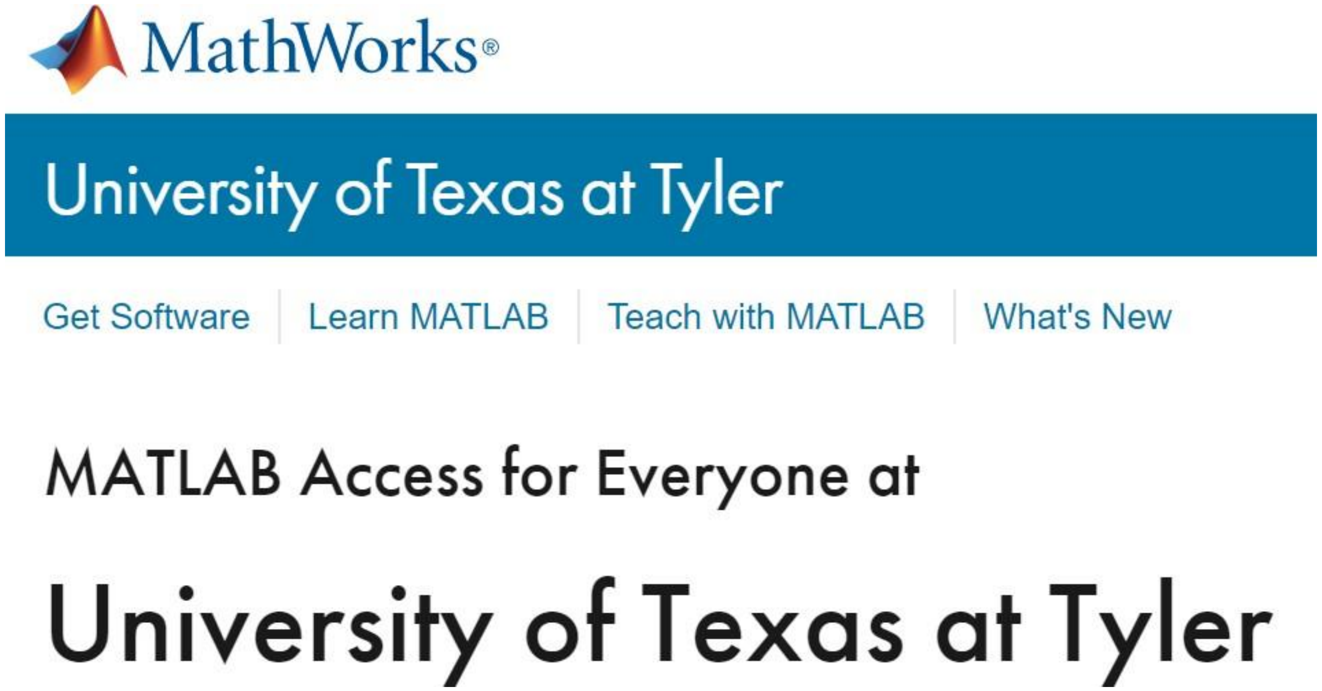
DEPARTMENT OF ELECTRICAL ENGINEERING

The University of Texas at TYLER Center for Health Informatics & Analytics

ORS Research Design & Data Analysis Lab

Office of Research and Scholarship

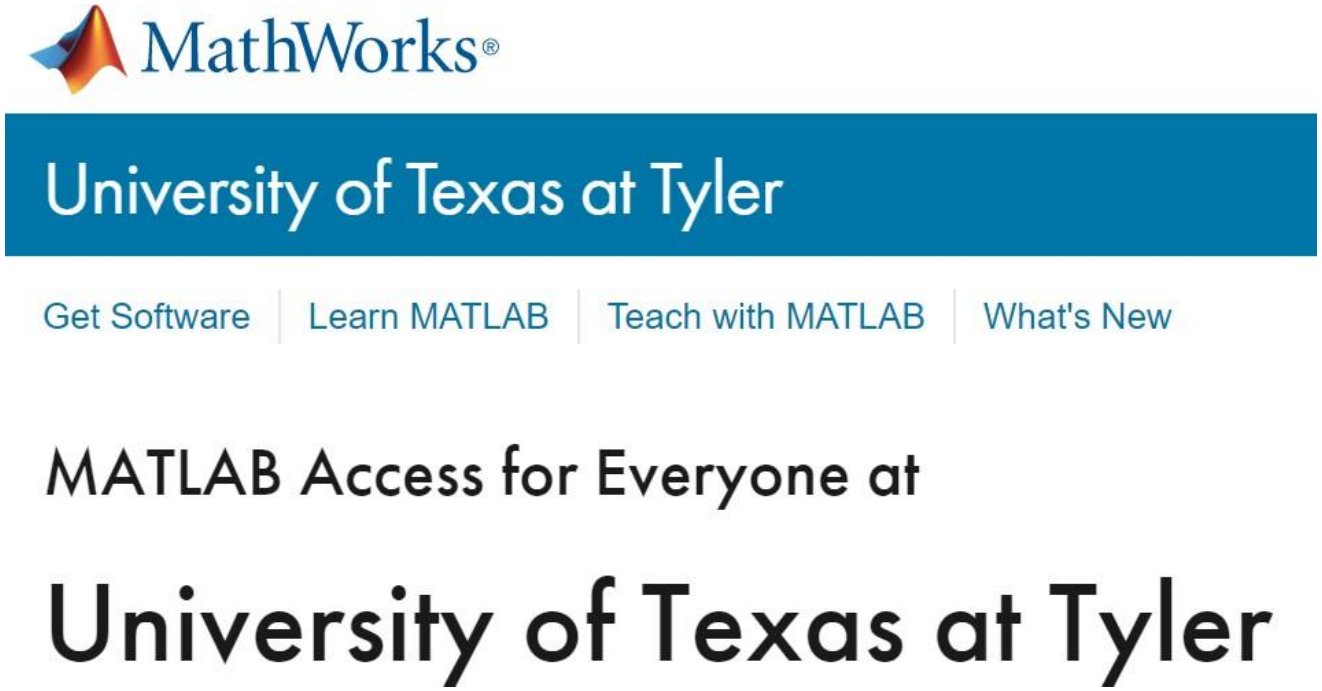
ANALYSIS PLATFORM

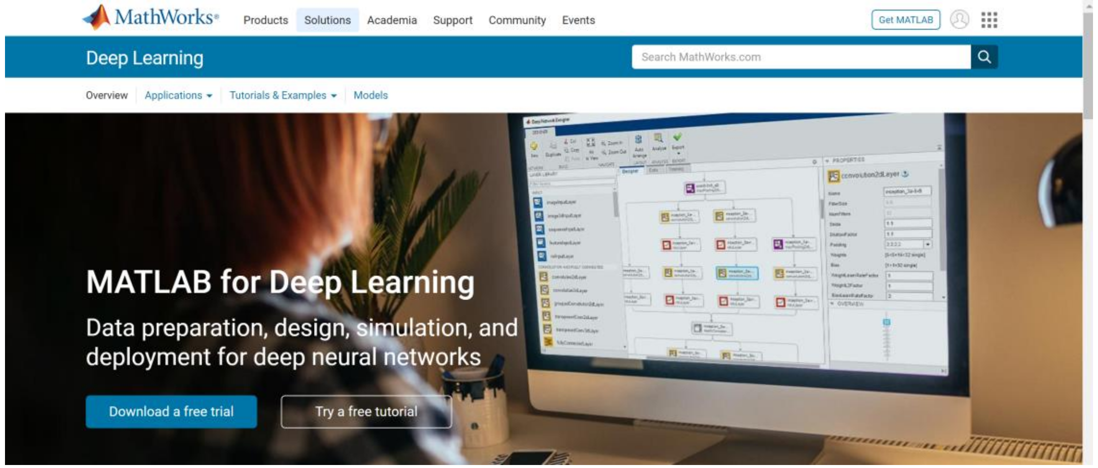


MATLAB R2021b

https://www.mathworks.com/academia/tah-portal/university-of-texas-at-tyler-1108545.html

ANALYSIS PLATFORM





https://www.mathworks.com/academia/tah-portal/university-of-texas-at-tyler-1108545.html

OUTLINE

- INTRODUCTION
- DIFFERENT DEEP LEARNING APPROACHES WITH EXAMPLES
- QUESTIONS

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- QUESTIONS

INTRODUCTION

- What is Machine Learning ?

- Machine Learning is a field of study that gives computers the ability to “learn” without being explicitly programmed
  - Prediction
  - Classification

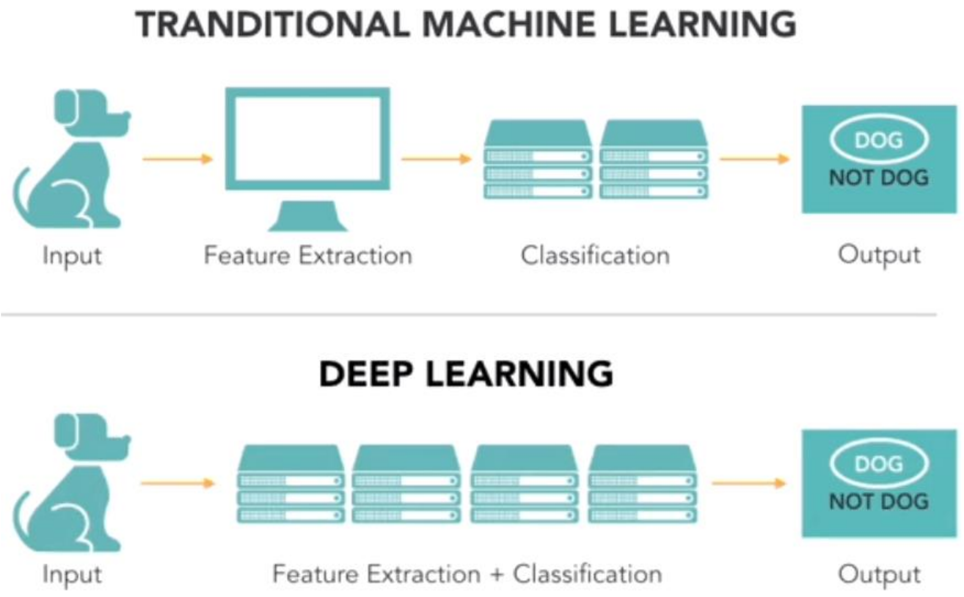
Samuel AL, IBM J. Research & Development, 1959, vol. 3 (3), 210-229

INTRODUCTION

➢ What is **Deep** Learning?

- Deep learning is a branch of machine learning that teaches computers to do what comes naturally to humans: learn from experience.

- Deep learning uses deep neural network with several layers to learn.

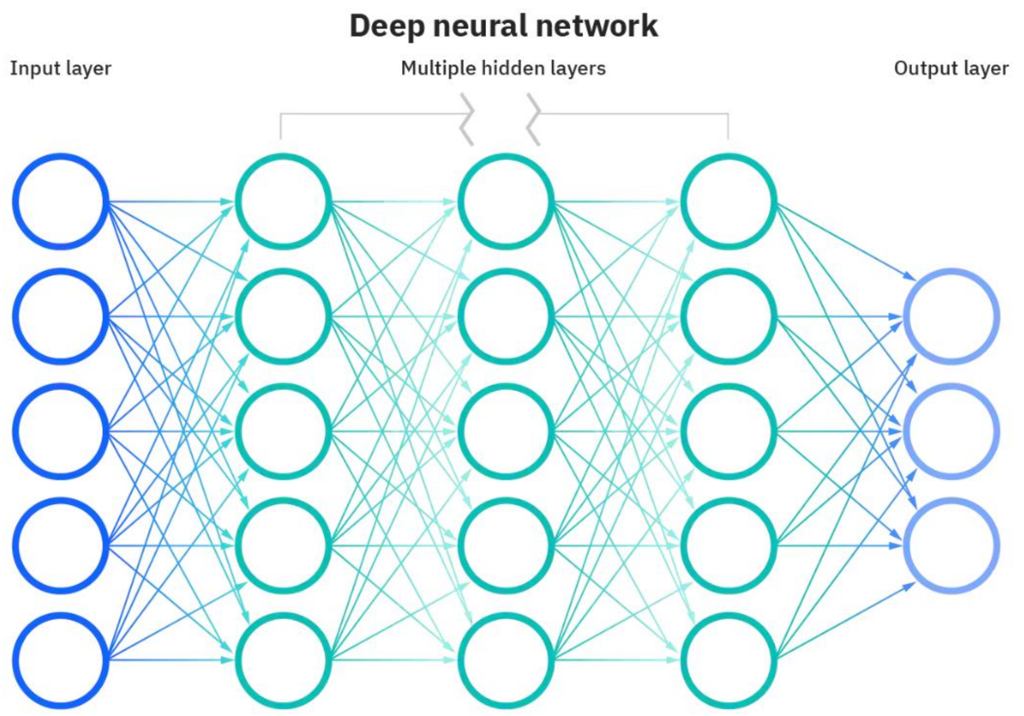


https://www.guru99.com/machine-learning-vs-deep-learning.html

INTRODUCTION

➢ What is **Deep** Learning?

- Deep learning describes models that utilize multiple layers to represent latent features at a higher and more abstract level
- The representations are learned from data rather than constructed by human engineers

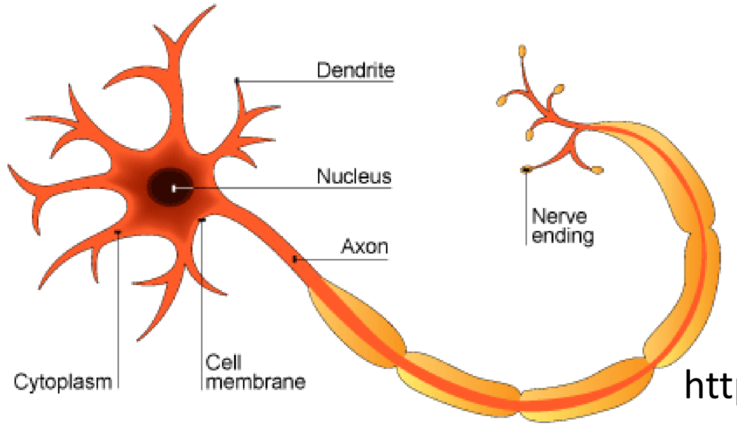


https://www.ibm.com/cloud/learn/neural-networks

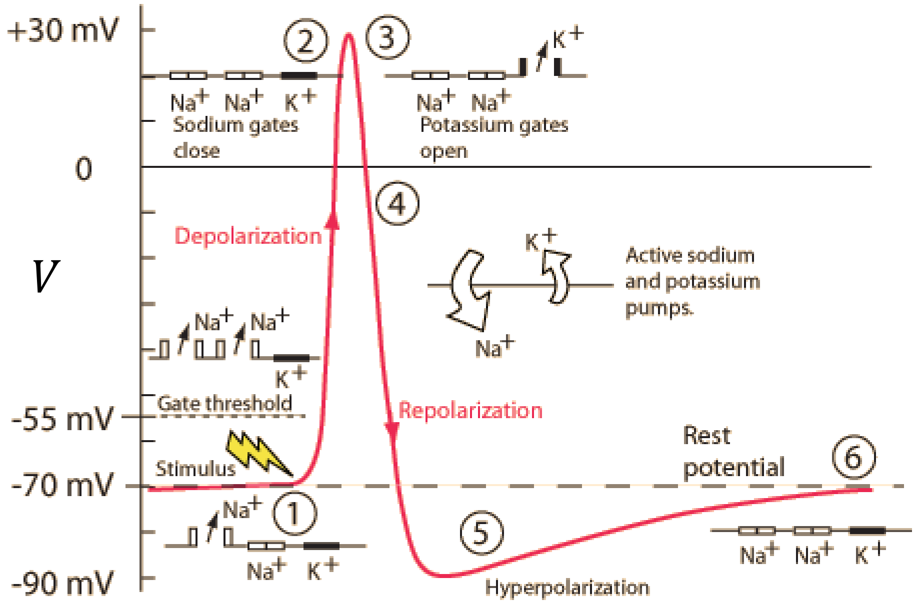
INTRODUCTION

- Inspiration from biological Neuron

- All or none
- Frequency rather amplitude helps in information processing



Biological Neuron

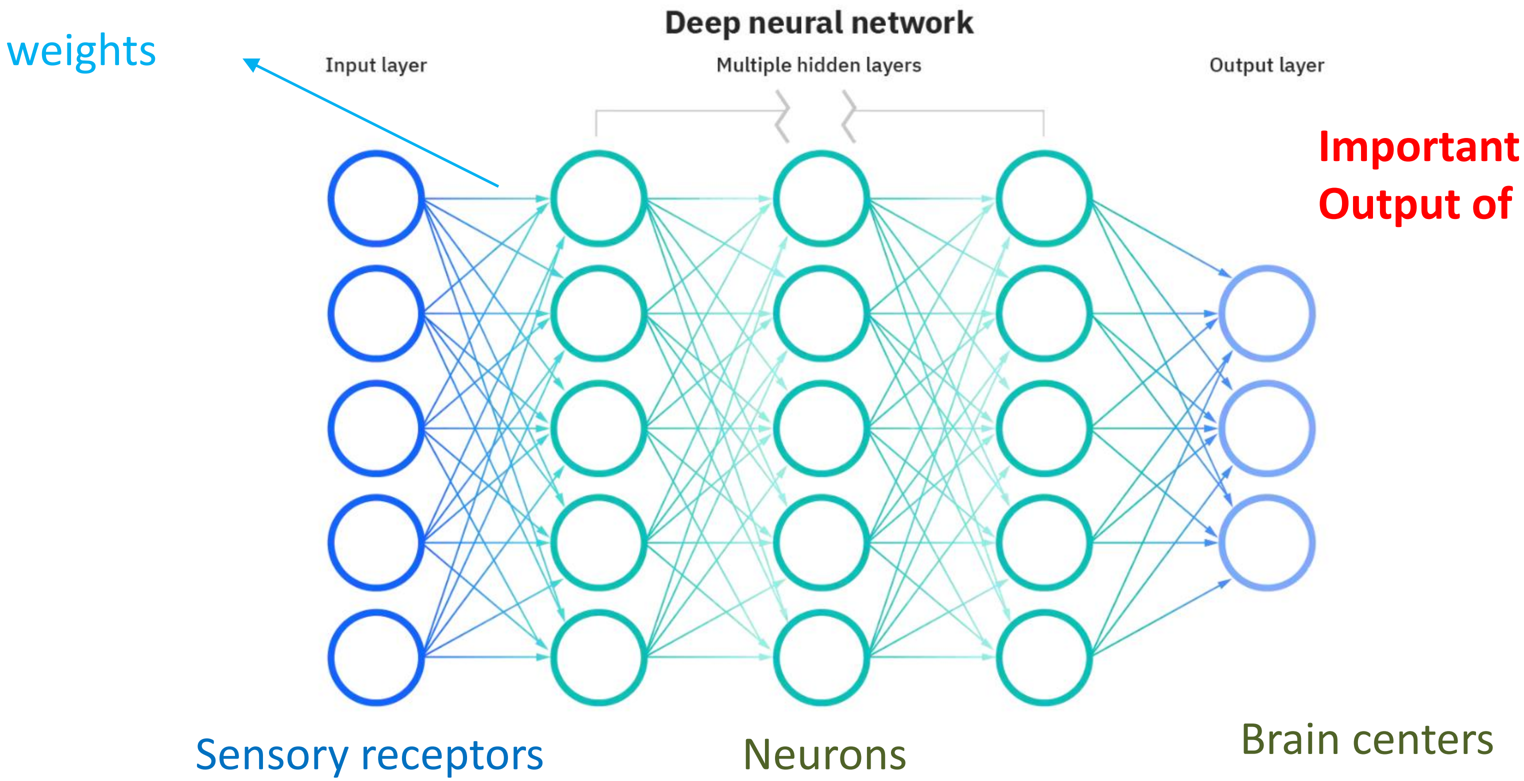


http://hyperphysics.phy-astr.gsu.edu/hbase/Biology/imgbio/actpot4.gif

https://pmgbiology.files.wordpress.com/2015/02/5d3d66ef622165ae607b3c02f6e603c524eececf.gif

INTRODUCTION

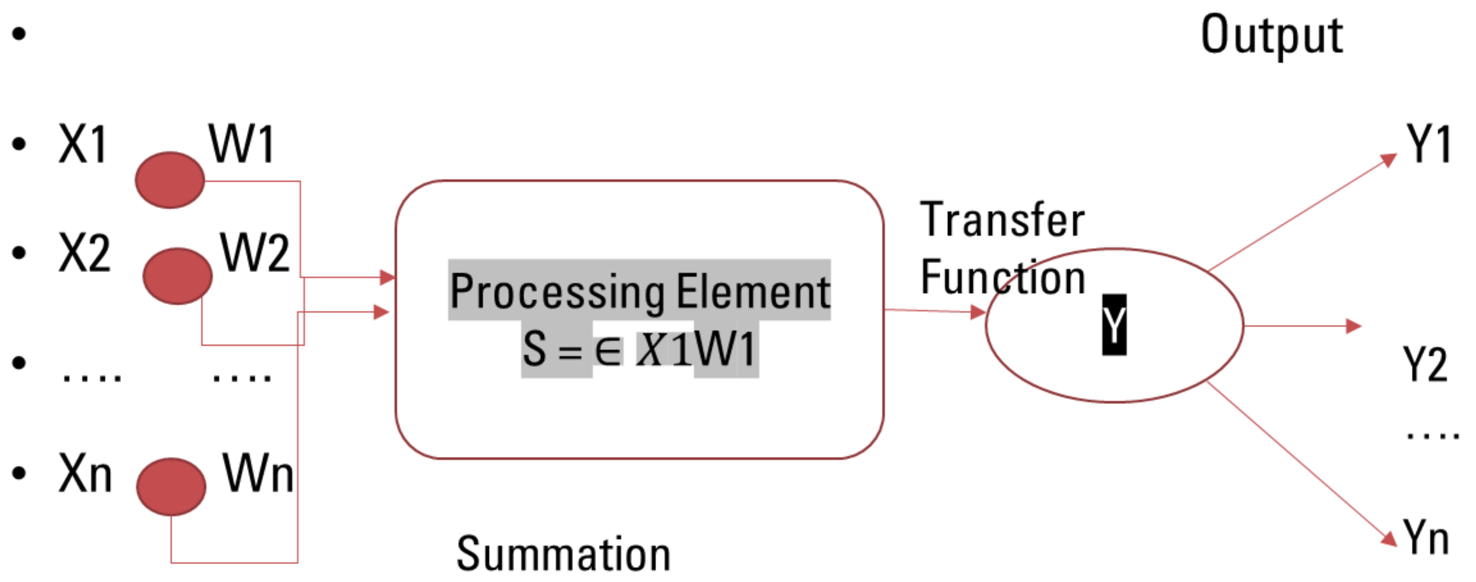
- From biological neural to artificial neural network

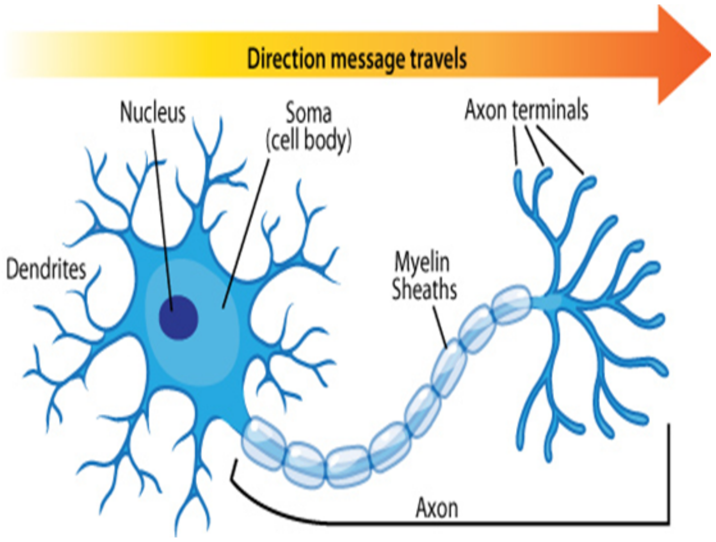


Important:
Output of each neuron produces 1 or 0

INTRODUCTION

- **How Artificial Neural Network Works?**

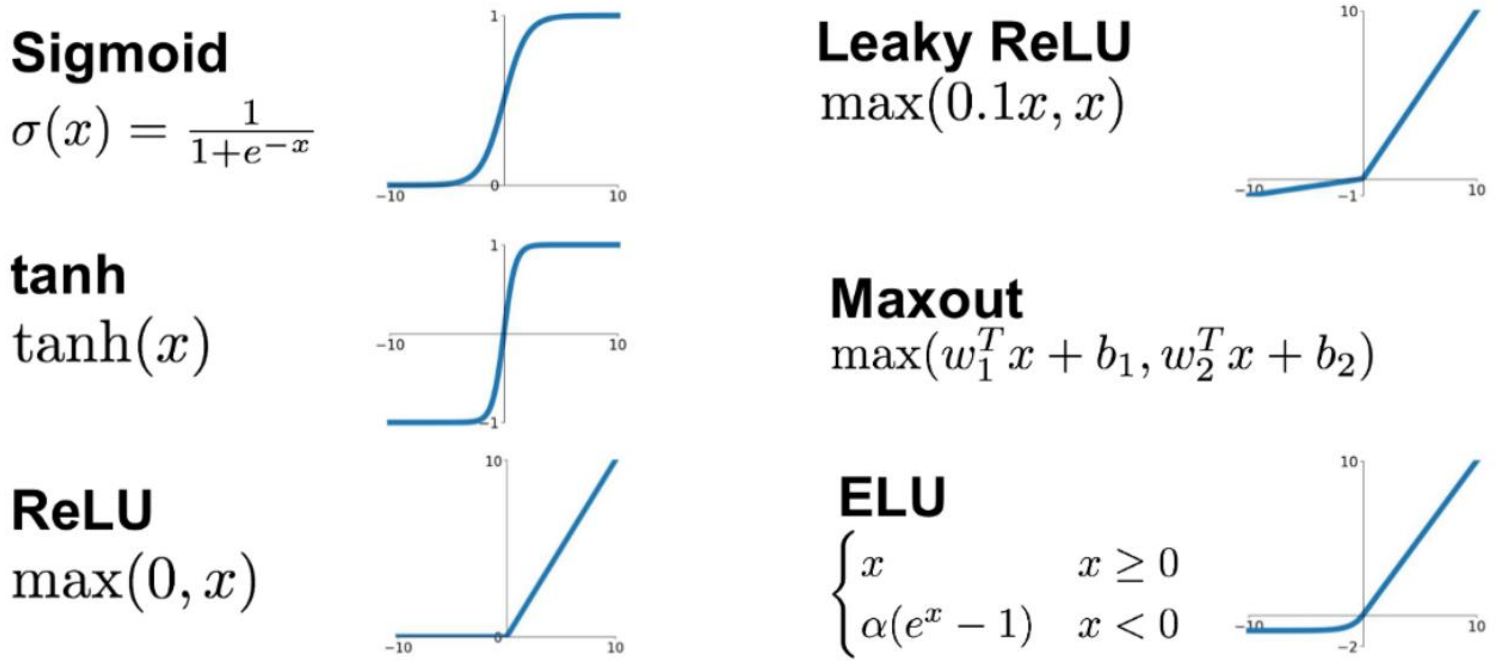




[What is Perceptron: A Beginners Guide for Perceptron [Updated]]

INTRODUCTION

- Activation Functions



https://medium.com/@shrutijadon/survey-on-activation-functions-for-deep-learning-9689331ba092

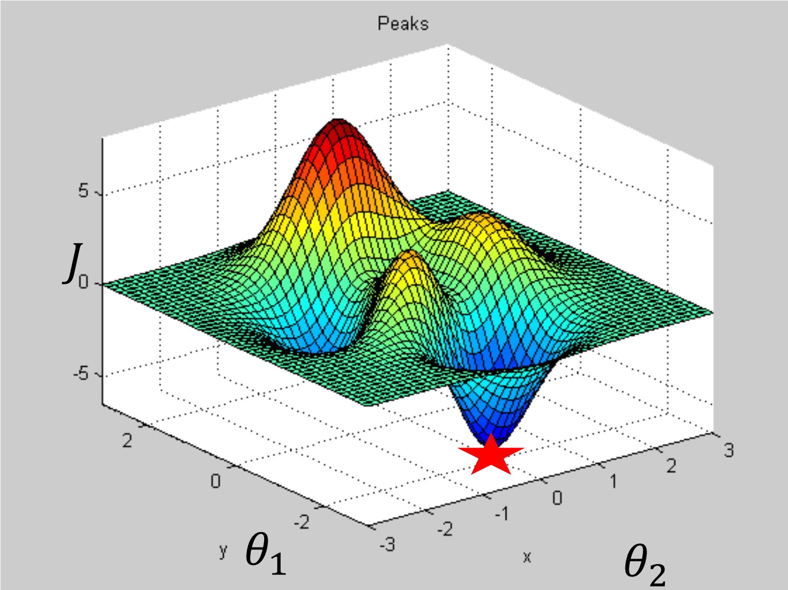
APPROACHES

- Gradient Descent

$$\hat{y}^i = \theta_0 + \theta_1 x_1^i + \theta_2 x_2^i + \cdots \ldots \ldots . + \theta_n x_n^i \qquad i = 1,2, \ldots \ldots . . m$$

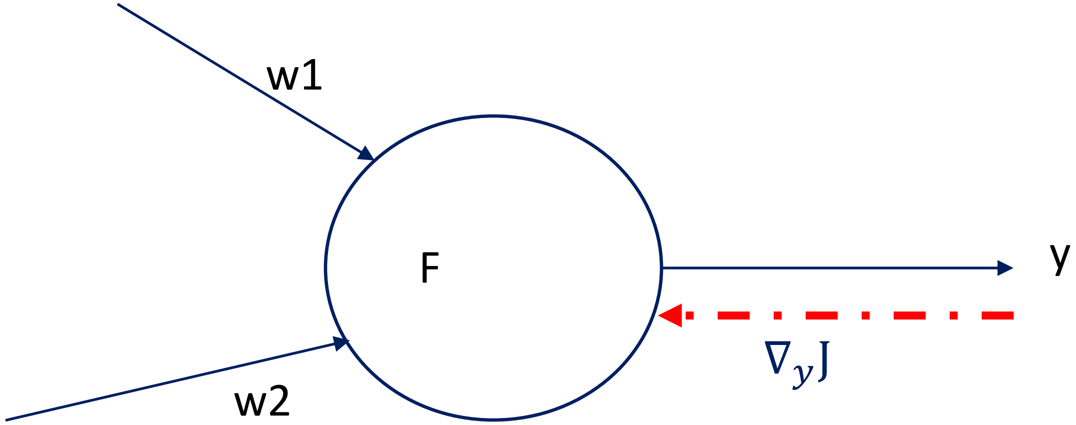
$$J = \left\langle \left(\hat{y}^i - y^i\right)^2 \right\rangle = \left(\hat{Y} - Y\right)^T \left(\hat{Y} - Y\right) = \frac{1}{m} \sum_{i=1}^{m} (\theta^T X^i - y^i)^2$$

$$\Theta^{k+1} = \Theta^k - \gamma \nabla_\Theta J(\Theta)$$ (Standard Machine Learning)



Back Propagation Algorithm (ANN)

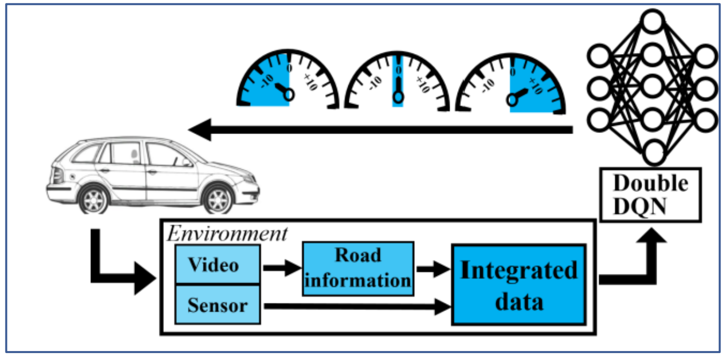
$$w^{k+1} = w^k - \gamma \nabla_w J$$



$\nabla_w J = \nabla_y J \nabla_w y$

INTRODUCTION

- Application of Deep Learning



Cruise Assistance

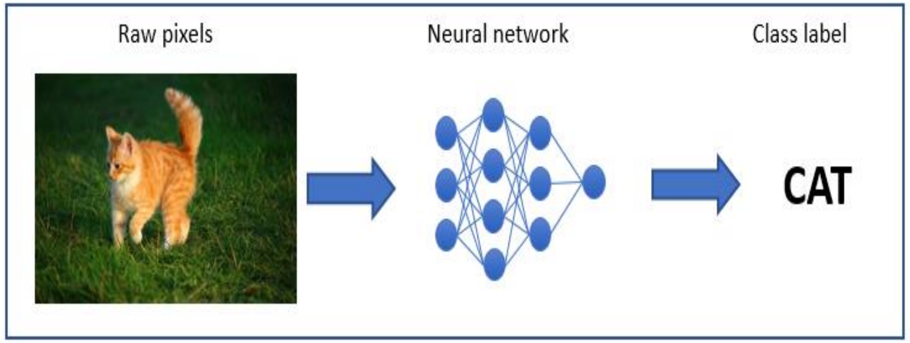
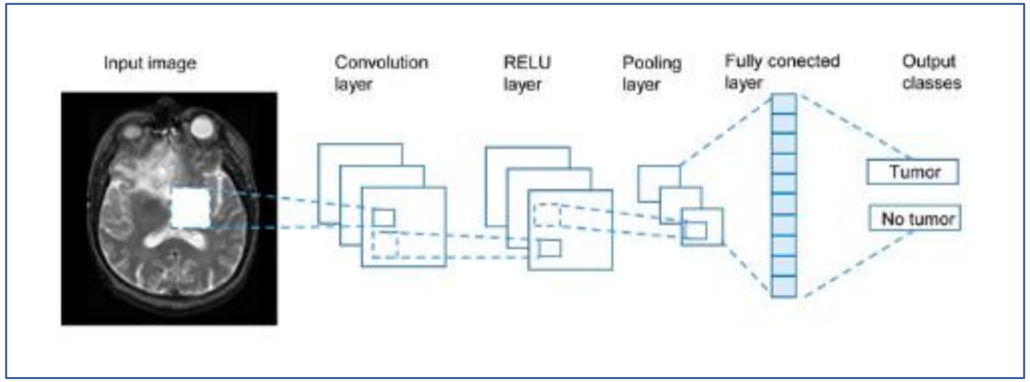


Image Recognition

Medical Imaging



http://dafne%20van%20kuppevelt/
https://www.semanticscholar.org/paper/Human-like-Autonomous-Vehicle-Speed-Control-by-Deep-Zhang-Sun/9ed56cf584eb66bdf576fcc58e84fecb2f51f547

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  Convolutional Neural Network
  Long Short-Term Memory

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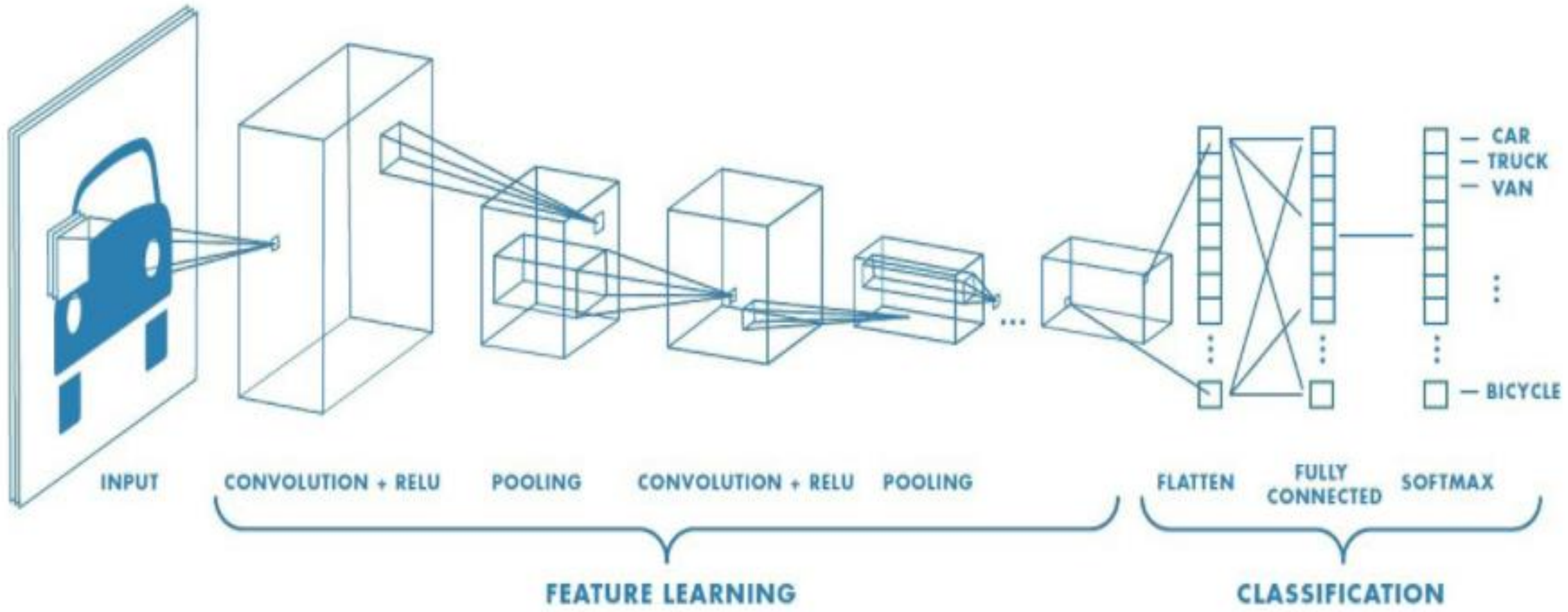
APPROACHES

- Convolutional Neural Network (Finite Impulse Response)



https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53

APPROACHES

- Convolutional Neural Network (Pretrained Network)

GoogLeNet, a pretrained deep convolutional neural network (CNN or ConvNet)

APPROACHES

- Example 1: Simple Image Classification using GoogleNET (using App)

APPROACHES

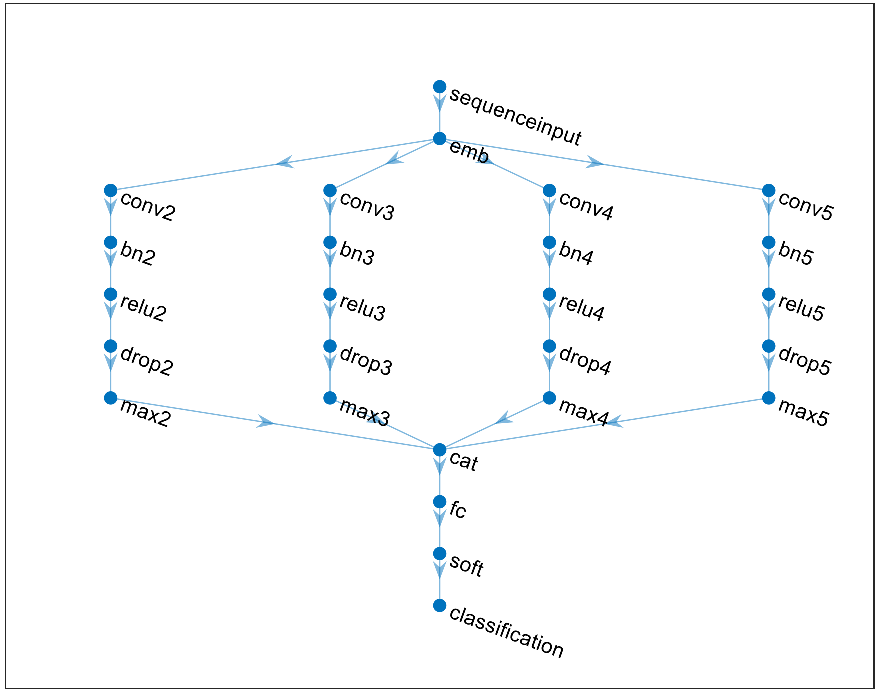
➢ Example 2: Classify Text Data Using Convolutional Neural Network

Description	Category	Urgency	Resolution	Cost
{'Items are occasionally getting stuck in the scanner spools.' }	{'Mechanical Failure'}	{'Medium'}	{'Readjust Machine' }	45
{'Loud rattling and banging sounds are coming from assembler pistons.'}	{'Mechanical Failure'}	{'Medium'}	{'Readjust Machine' }	35
{'There are cuts to the power when starting the plant.' }	{'Electronic Failure'}	{'High' }	{'Full Replacement' }	16200
{'Fried capacitors in the assembler.' }	{'Electronic Failure'}	{'High' }	{'Replace Components'}	352
{'Mixer tripped the fuses.' }	{'Electronic Failure'}	{'Low' }	{'Add to Watch List' }	55
{'Burst pipe in the constructing agent is spraying coolant.' }	{'Leak' }	{'High' }	{'Replace Components'}	371
{'A fuse is blown in the mixer.' }	{'Electronic Failure'}	{'Low' }	{'Replace Components'}	441
{'Things continue to tumble off of the belt.' }	{'Mechanical Failure'}	{'Low' }	{'Readjust Machine' }	38

APPROACHES

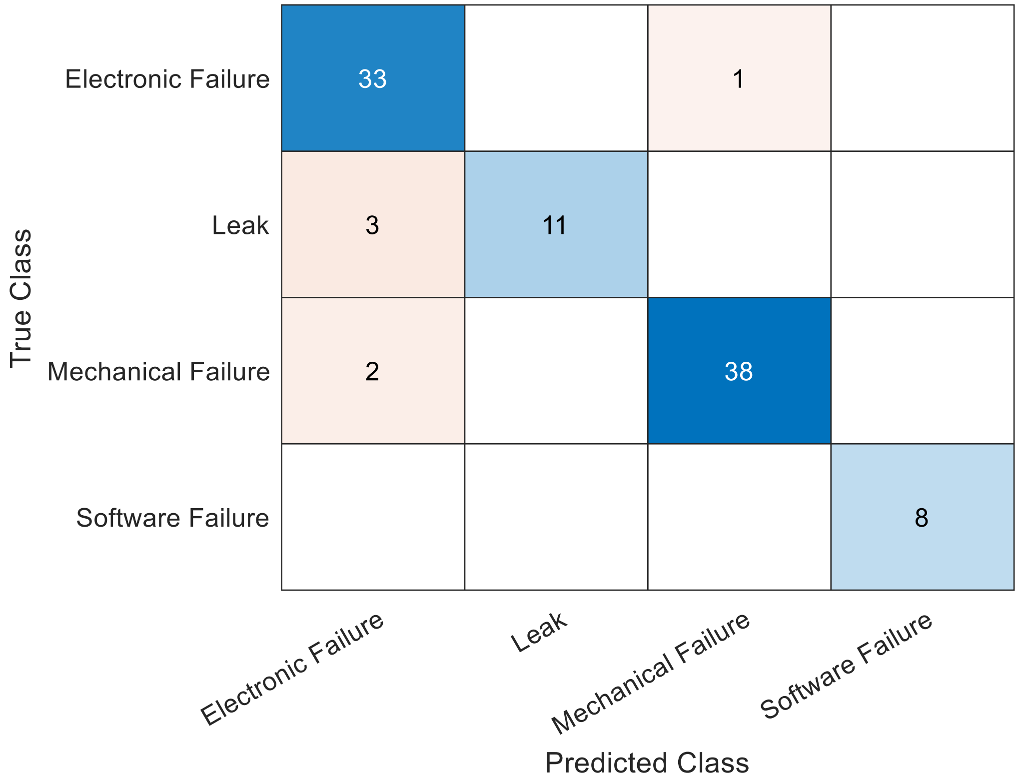
- Example 2: Classify Text Data Using Convolutional Neural Network

Network Architecture



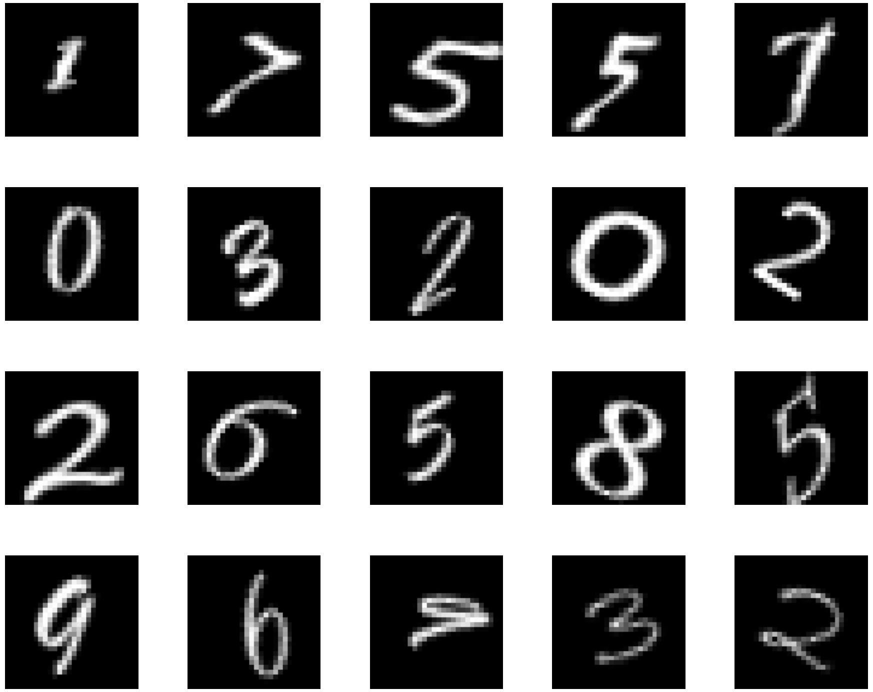
APPROACHES

- Example 2: Classify Text Data Using Convolutional Neural Network



APPROACHES

- Example 3: Regression model using CNN to predict the angles of rotation of handwritten digits.



APPROACHES

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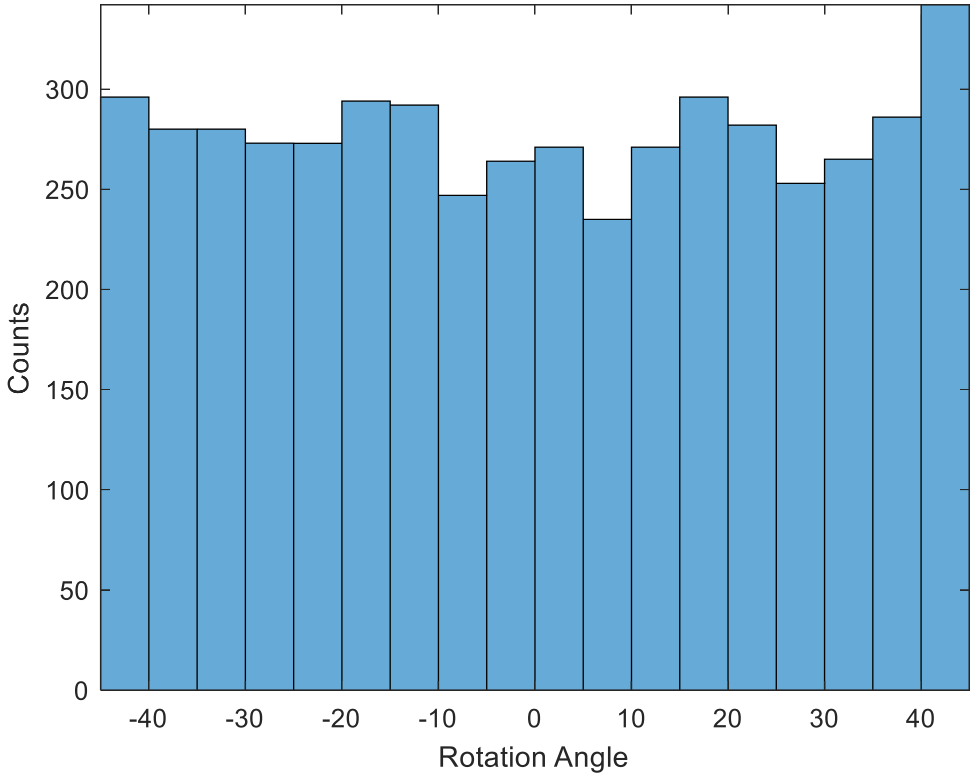

APPROACHES

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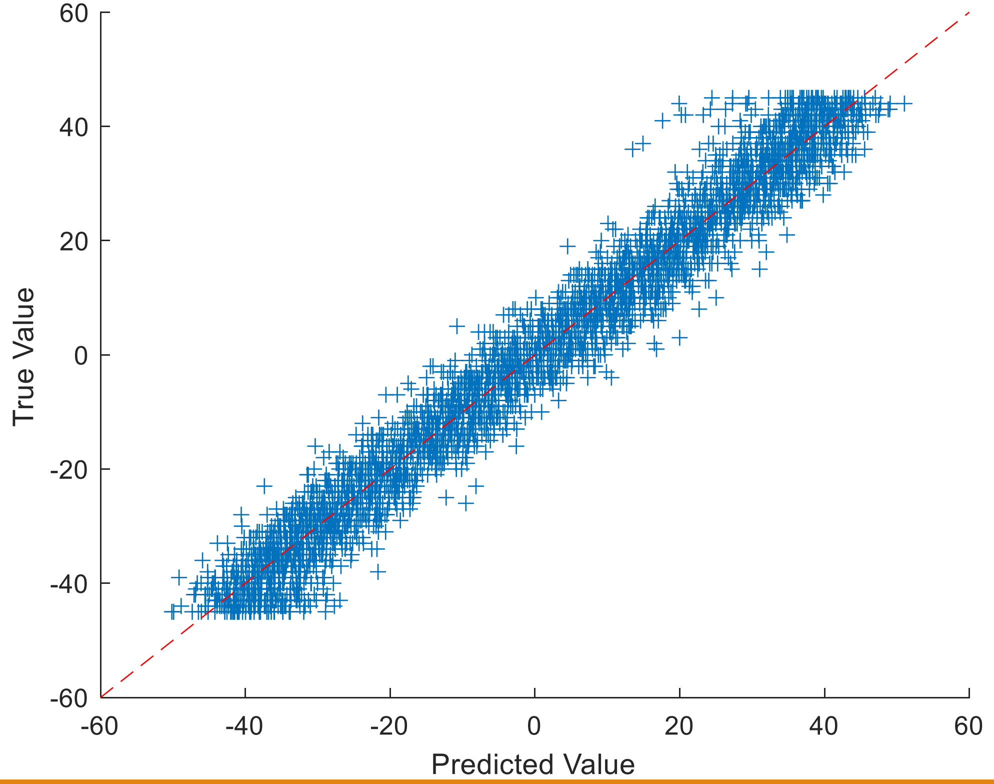
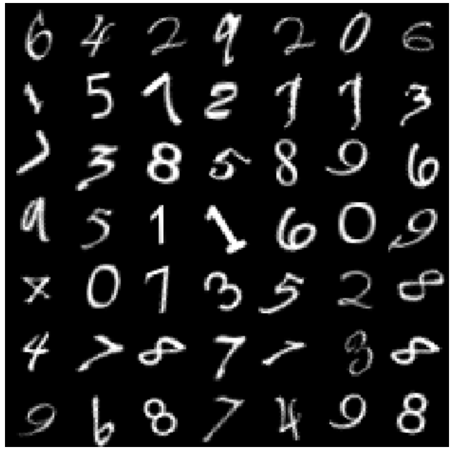


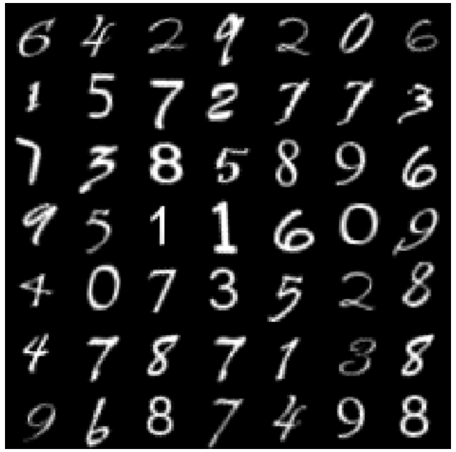
APPROACHES

- Example 3: Regression model using CNN to predict the angles of rotation of handwritten digits.

Original



Corrected



OUTLINE

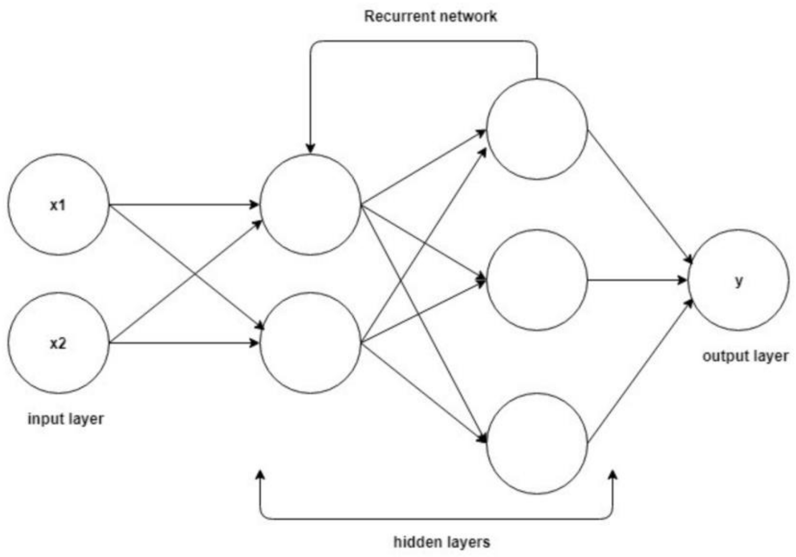
- DIFFERENT DEEP LEARNING APPROACHES WITH EXAMPLES

  Convolutional Neural Network
  Long Short-Term Memory

APPROACHES

- Long Short-Term Memory (LSTM) Network (Infinite Impulse Response)

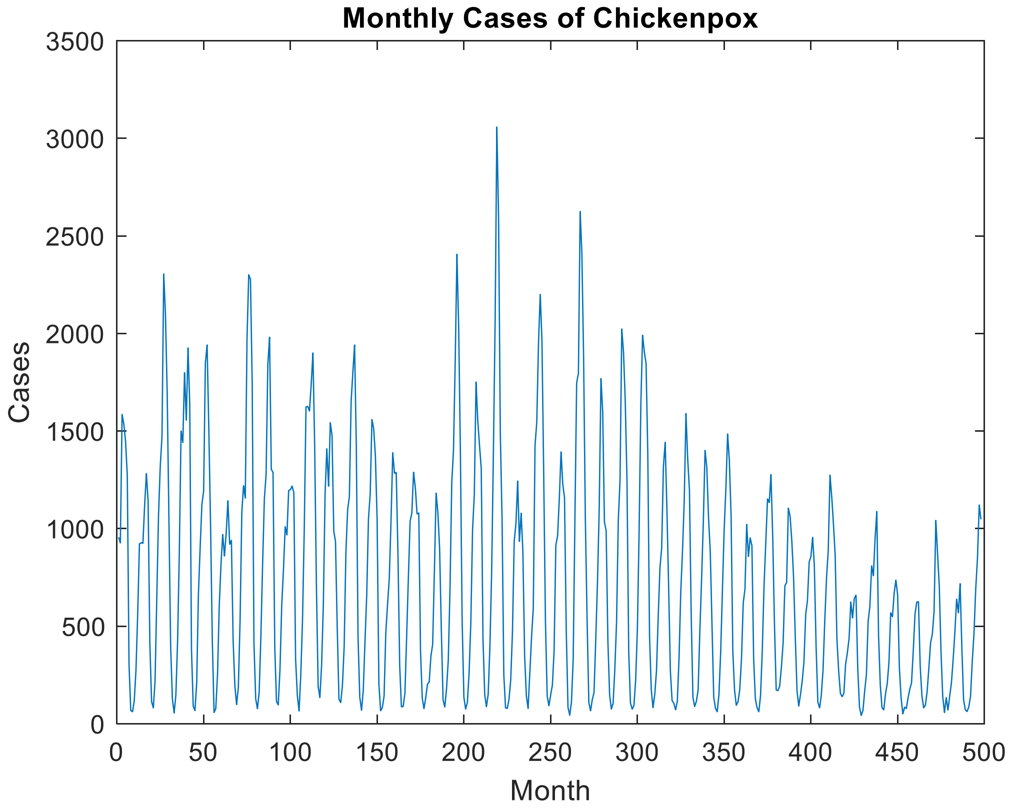
Special category of network that are suitable for learning long-term dependencies.



https://towardsdatascience.com/machine-learning-recurrent-neural-networks-and-long-short-term-memory-lstm-python-keras-example-86001ceaaebc

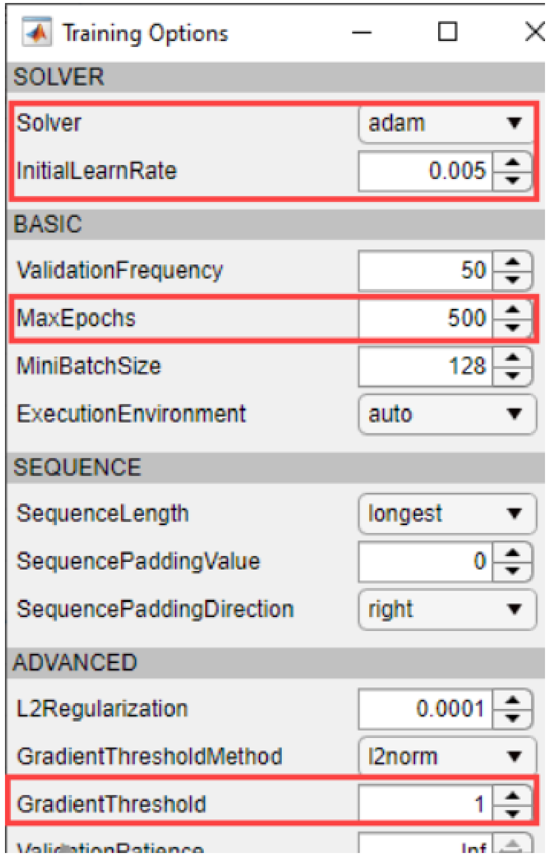
APPROACHES

Example 4: LSTM Regression Network for Time Series Forecasting Using Deep Network Designer (App)



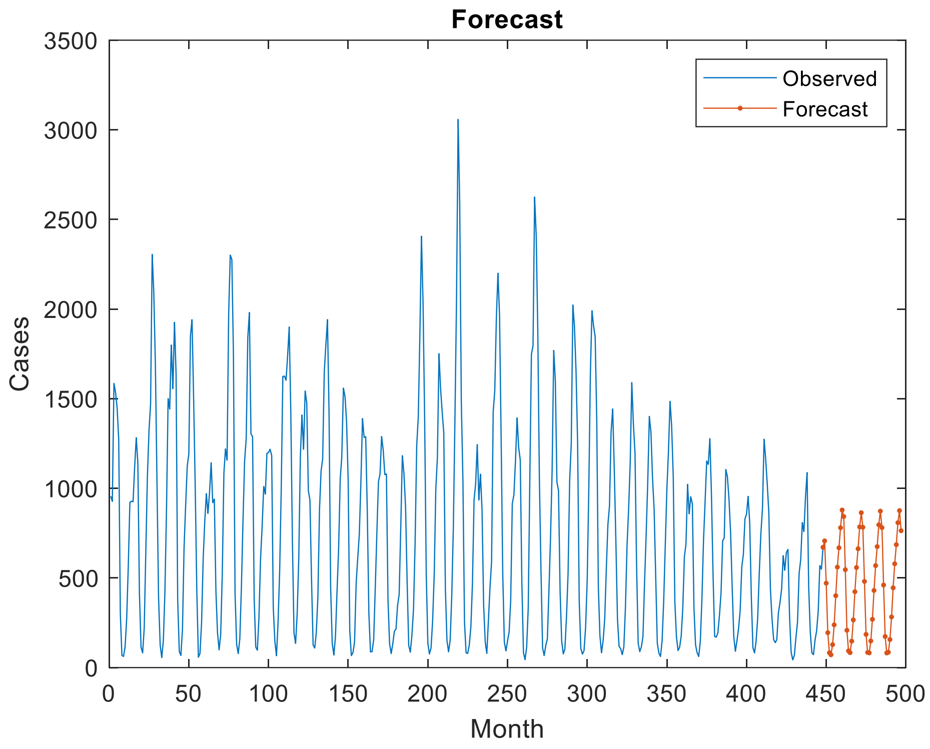
APPROACHES

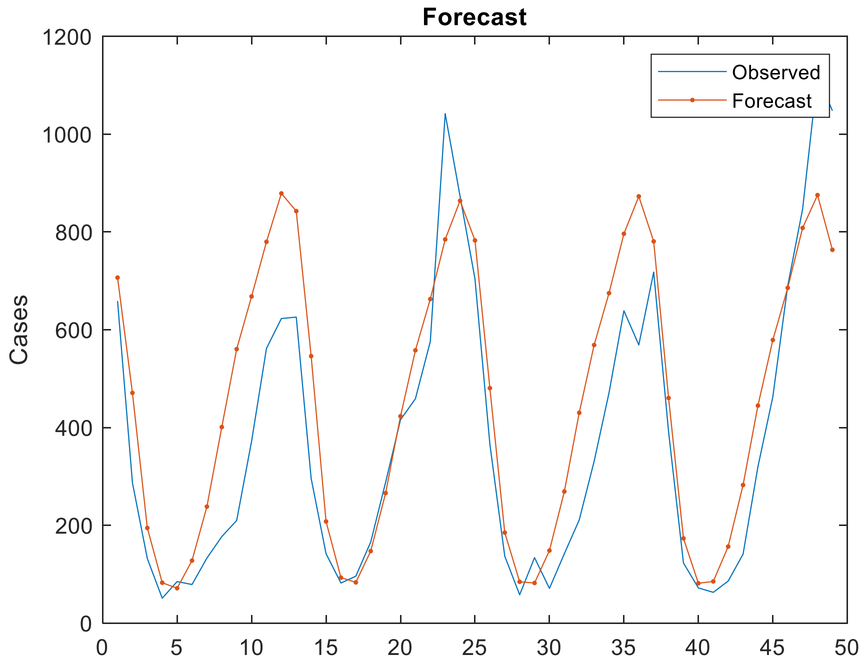
Example 4: LSTM Regression Network for Time Series Forecasting Using Deep Network Designer (App)



APPROACHES

Example 4: LSTM Regression Network for Time Series Forecasting Using Deep Network Designer (App)





CONCLUSION

- Deep Learning Networks can be used for regression and classification
- Forecasting or Prediction is a salient feature of ANN
- Need large amount of data to train the models

THANK YOU

ORS Research Design & Data Analysis Lab
Office of Research and Scholarship

SBIR: RAE (Realize, Analyze, Engage) - A digital biomarker based detection and intervention system for stress and carvings during recovery from substance abuse disorders.
PIs: M. Reinhardt, S. Carreiro, P. Indic

STARs Award

The University of Texas System
P. Indic (PI, UT Tyler)

Department of Veterans Affairs

Design of a wearable sensor system and associated algorithm to track suicidal ideation from movement variability and develop a novel objective marker of suicidal ideation and behavior risk in veterans.
Clinical Science Research and Development Grant (approved for funding),
P. Indic (site PI, UT-Tyler)
E.G. Smith (Project PI, VA)
P. Salvatore (Investigator, Harvard University)

Design of a wearable biosensor sensor system with wireless network for the remote detection of life threatening events in neonates.

National Science Foundation Smart & Connected Health Grant
P. Indic (Lead PI, UT-Tyler)
D. Paydarfar (Co PI, UT-Austin)
H. Wang (Co PI, UMass Dartmouth)
Y. Kim (Co PI, UMass Dartmouth)

Pre-Vent

National Institute Of Health Grant
P. Indic (Analytical Core PI, UT-Tyler)
N. Ambal (PI, Univ. of Alabama, Birmingham)

ViSiOn
P. Indic (site PI, UT-Tyler)
P. Ramanand (Co-I, UT Tyler
N. Ambal, (PI, Univ. of Alabama, Birmingham)

QUESTIONS